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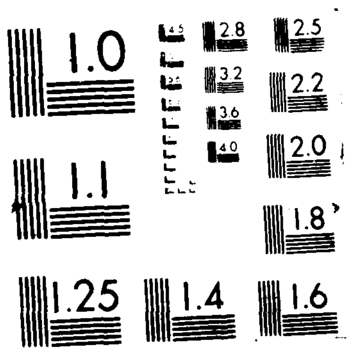
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QUANTIFYING EXPERIENCE IN THE VALUE OF HUMAN CAPITAL

MAJOR R. THEODORE ROTH

DEPARTMENT OF ECONOMICS AND GEOGRAPHY

JULY 1987

FINAL REPORT

UNITED STATES AIR FORCE ACADEMY

DEAN OF THE FACULTY

UNITED STATES AIR FORCE ACADEMY

COLORADO SPRINGS, CO 80840

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The present study will attempt to place a dollar value on human capital gained through training and work experience. Specifically, this study will quantify the value of human capital of Air Force officers.

Calculating the present discounted value of future returns from a capital investment is no more than an accounting question. Calculating the present discounted value of future net returns for labor is much more difficult. Labor is paid the value of its marginal product, which is determined by the marginal revenue of an additional unit of output and the marginal physical product of labor. This productivity of labor can be improved through training and experience. Firms which provide specific job training to an individual make that investment based upon the fact that the increased labor productivity, and its associated returns to the firm from this training, will increase firm profits. Trying to actually quantify these returns to human capital gained through training and experience however, is very difficult. This is complicated by the fact that the Air Force provides a product, "National Defense," which is not sold directly in the marketplace, and thus has no market price to determine individual marginal revenue product. (See Reverse)

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In order to calculate the value of an individual to an organization one must first determine their productivity. A model for calculating this productivity for an Air Force officer has been developed. This productivity model for the Air Force is based upon the following assumptions: (1) an individual's productivity is an increasing function of his/her years of service, and increases at a decreasing rate, (2) over the lifetime of employment of the individual, the Air Force realizes total returns equal to total expenditures on the individual for compensation and training.

Having developed a productivity vs. time profile for a particular Air Force job, the Human Capital Value of a person at a particular time can be determined by taking the present discounted value of future returns minus costs plus the replacement costs for that individual (hiring, training and experiencing costs).

Actual results of the model can be developed by analyzing individual Air Force job titles. Training costs, compensation and expected retirement costs are used to develop productivity profiles for these different jobs. Value of an individual's human capital can then be determined from any point in the person's career to any time in the future. Policy implications concerning compensation and other personnel programs can then be made to optimize the structure of the officer corps in the Air Force.

QUANTIFYING EXPERIENCE IN THE
VALUE OF HUMAN CAPITAL

by

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ABSTRACT

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SECTION I

INTRODUCTION

Individuals come to the workplace with certain basic characteristics. Through education, training and experience, each individual becomes more productive and thus increases their human capital. The military services are some of the largest investors in human capital. They train thousands of people each year to do the many jobs within the services. These investments in human capital can range from small dollar amounts, up to millions of dollars per individual.

In the Air Force, this human capital takes on two dimensions. The first is the specific training that an individual receives to perform in a certain Air Force Specialty Code (AFSC). The second is the productivity enhancement that his years of experience have added to his human capital. The task of this research is to attempt to value this experience for Air Force officer personnel.

Unlike profit maximizing firms in the economy, the Air Force does not sell a product in the marketplace. Thus it is impossible to place a direct value on an individual's productivity or output. However, by making certain assumptions about the economic behavior of the Air Force, a model will be developed which will put a dollar value on an individual's productivity and experience. The development of this theoretical model will be the primary product of this paper. The model will provide dollar values of future returns vs. costs. These results will indicate the appropriate policy actions for Air Force personnel decisions.

SECTION II

HUMAN CAPITAL THEORY

Development of the Theory

Like any other productive process, the Air Force mixes land (raw materials), labor and capital to produce its "output" of National Defense. This study will look specifically at the labor input. Early economic theory treated the labor input as a strictly variable input which was universal in all production processes. (14:538) More recent thinking and written literature ascribes more specific characteristics to this labor input than this earlier, simplified model. (14:538) It is now recognized that labor takes on certain characteristics of capital. Labor is trained to perform certain skills which are applicable to a particular firm, and the firm realizes returns on its investment in "human capital" just as it does from investments in physical capital. (4:16-17) The Air Force, and the Armed Forces in general, provide significant amounts of training to enhance the productivity of its personnel. Labor then takes on some of the characteristics of a fixed factor of production. (14:539-543)

Since labor takes on certain characteristics of capital, one can analyze the circumstances which will lead to investments in this human capital. An individual will invest in training and education if the future compensation is greater than the opportunity costs of the training. (20:409-411) Firms will invest in training workers if they too will realize future gains greater than the opportunity costs of providing the training. (4:28) A noted labor economist, Professor

Gary Becker, has provided the theoretical basis for human capital theory. Becker's pioneering study in the book entitled, Human Capital, looks at the general topic of human capital and is a "general analysis of investment in human capital." (4:15)

His work has important implications for the study at hand. To quote the important portions of his work, for the purposes of this study, would be to copy Chapter Two of his text in its entirety. The model presented here does not have the theoretical completeness of his work, since the present task is to describe human capital in the Air Force, and not the economy in its entirety. Still, many of his conclusions apply to the Air Force personnel situation, as well. The following section presents the conclusions of his research and some important concepts.

> It eventually became apparent that this general analysis would do much more than fill a gap in formal economic theory: it offers a unified explanation of a wide range of empirical phenomena which have either been given ad hoc interpretations or have baffled investigators. Among these phenomena are the following: (1) Earnings typically increase with age at a decreasing rate. Both the rate of increase and the rate of retardation tend to be positively related to the level of skill. (2) Unemployment rates tend to be inversely related to the level of skill. (3) Firms in underdeveloped countries appear to be more "paternalistic" toward employees than those in developed countries. (4) Younger persons change jobs more frequently and receive more schooling and on-the-job training than older persons do. (5) The distribution of earnings is positively skewed, especially among professional and other skilled workers. (6) Abler persons receive more education and other kinds of training than others. (7) The division of labor is limited by the extent of the market. (8) The typical investor in human capital is more impetuous and thus more likely to err than is the typical investor in tangible capital.
>
> What a diverse and even confusing array! Yet all these, as well as many other important empirical implications, can be derived from very simple theoretical arguments. (4:16)

General and Specific Training

There are two basic types of training which an individual receives during his lifetime. General training, such as formal education, is applicable to all jobs in the economy. Specific training would be applicable to a particular job and would thus be job specific. One could think of a continuum of training with completely general training at one end of the spectrum and skill specific training at the other. Several general statements can be made about training along this spectrum. 1) If training is job or skill specific, then it is applicable only to one firm. As an example, a missile launch officer in the Air Force might find his skills only usable in the Air Force (although it is recognized that certain of his skills would be transferable to the civilian sector). 2) The more job specific the training, the higher the proportion of the cost will need to be born by the employer. 3) Training will be given based upon expected returns to the firm and will only be given if the expected returns are greater than the costs.(4:28) This theoretical conclusion is the primary information used in developing the model in this paper. In the Air Force, all of these training costs will be directly born by the Air Force for all job related training and for quite a bit of formal education costs for its members. Workers may also bear part of the cost in that they may work for lower wages than they might otherwise earn. (4:28) Becker discusses these principles and how they apply to the military.

> Income-maximizing firms in competitive labor markets would not pay the cost of general training and would pay trained persons the market wage. If, however, training costs

were paid, many persons would seek training, few would quit during the training period, and labor costs would be relatively high. Firms that did not pay trained persons the market wage would have difficulty satisfying their skill requirements and would also tend to be less profitable than other firms. Firms that paid both for training and less than the market wage for trained persons would have the worst of both worlds, for they would attract too many trainees and too few trained persons.

These principles have been clearly demonstrated during the last few years in discussions of problems in recruiting military personnel. The military offers training in a wide variety of skills and many are very useful in the civilian sector. Training is provided during part or all of the first enlistment period and used during the remainder of the first period and hopefully during subsequent periods. This hope, however, is thwarted by the fact that reenlistment rates tend to be inversely related to the amount of civilian-type skills provided by the military. Persons with these skills leave the military more readily because they can receive much higher wages in the civilian sector. Net military wages for those receiving training are higher relative to civilian wages during the first than during subsequent enlistment periods because training costs are largely paid by the military. Not surprisingly, therefore, first-term enlistments for skilled jobs are obtained much more easily than are reenlistments.

The military is a conspicuous example of an organization that both pays at least part of training costs and does not pay market wages to skilled personnel. It has had, in consequence, relatively easy access to "students" and heavy losses of "graduates." Indeed, its graduates make up the predominant part of the supply in several civilian occupations. For example, well over 90 per cent of United States commercial airline pilots received much of their training in the armed forces. The military, of course, is not a commercial organization judged by profits and losses and has had no difficulty surviving and even thriving. (4:24-25)

Since an individual officer is faced with the question of whether to remain in the Air Force or separate, he must weigh the opportunity cost of remaining in the Air Force. This opportunity cost to the individual will be positively related to the dollar value of his extra training. (4:24-25) This is a measure of his own human capital which has increased his worth to society. The pay and promotion rates (with

few exceptions) are the same for all officers, no matter what amount of human capital enhancing training they may have received. This leads to an inverse relationship between retention probability and the expense of training. (4:24-25) Consequently, a personnel management problem is created which is exacerbated by the institutional constraints of the Air Force personnel system. This theoretical conclusion is verified by empirical work done by Gorman C. Smith in his 1964 dissertation from Columbia University, entitled, "Occupational Pay Differentials for Military Technicians." (21:1-3) These institutional constraints have moved the Air Force to a non-optimal, inefficient personnel policy. It is non-optimal in the sense that it is not a least cost policy.

SECTION III

ACCOUNTING METHODOLOGIES OF HUMAN CAPITAL ACCOUNTING

There are several different accounting methodologies which have been discussed in the literature for valuing human resources. In fact, the Air Force has spent considerable effort to develop a consistent, usable costing model. (1:i) The Air Force seems to have developed reasonable means of determining the costs of training programs and operational activities, but is still searching for a means to determine the proper way of costing manpower. (2:1-2) This has led to the current research and modeling efforts.

The "economic" literature on the subject of human capital addresses the subject from a theoretical standpoint. Only in "accounting" literature can one find actual theories for accounting or putting any dollar values on human capital. Again, these concepts are theoretical in nature and are not specific methodologies for developing dollar values of human capital, or experience as this research would like to value. The three main models are the 1) Accounting, or Historical Approach, 2) Replacement Cost Approach and the 3) Economic or Discounted Cash Flow Approach. (18:7)

The Historical or Accounting Approach values human capital by summing all of the expenditures and investment made by the firm in the individual to get that individual to his current state. This accounting would include such things as the costs of recruiting, hiring, training and development. This model has several advantages to valuing human resources, not the least of which is its simplicity.

It basically assumes that when a person is through with training, he is fully productive to the firm and the firm begins to realize a return on its investment, just as it would from physical capital. (18:7) There are several serious disadvantages with this type of model. The first, and major, difficulty is that there is no relationship between the historical investment and an individual's current value to the firm. The other criticisms of the model deal with accounting principles and how amortization, depreciation, write offs and discount rates are considered. Accountants are more interested in developing a way to account for human capital from a profit/loss or tax standpoint than in trying to determine the economic value of an individual. (18:9)

The second method, the replacement cost model, is similar to the historical cost model previously discussed. However, instead of using the expenditures on the individual in question, it ascertains the same costs to replace that individual at today's prices. (18:12) This approach has the advantage of only using pertinent costs in today's market to replace a departing individual. For our purposes, this approach has the same limitations as the historical approach, namely that it is an accounting of the expenditures to get an individual to a certain state. However, neither method takes into account any foregone future value of the individual to the firm due to his acquired experience.

The third approach, and the one which best estimates the total "economic" value of an individual, is the economic or discounted cash flow model. This model looks at the individual at a specific point in time. (18:15) His value to the firm will now include the expected

returns to the firm over his future term of employment, discounted to the present. Discounted costs of his employment will be subtracted from this figure to give net returns to the firm of future employment of this individual. (18:15) In addition, his continued employment allows the firm to avoid replacement costs, so these must be added to the value of the individual in this state. This formulation assumes the individual need never be replaced if he continues to work for the firm. (18:15) Conceptually, this approach will allow us to put a value on experience in that it requires a measure of future productivity in order to value human capital. That "value of experience" is one of the goals of the current research. As applied to the Air Force, this model can be expressed as follows in mathematical terms:

$$V_o = \sum_{t=1}^{T} \frac{R_t}{(1+d)^t} - \sum_{t=1}^{S} \frac{C_t}{(1+d)^t} + REP_t \qquad (1)$$

V_o = The human capital value of a person at time zero.

R = Returns or "revenue" to the Air Force of future years employment for this individual.

t = year, (t=1, ..., T or S)

T = Number of years of future employment

REP = Replacement costs (to hire, train and experience a replacement)

d = Discount rate for future returns and costs

C = future remuneration to the individual, to include pay and benefits, retirement etc.

S = Number of years that remuneration is paid (may be greater than T if the individual reaches 20 years total military service)

Notice that facts must be known with certainty in order to use this equation to value future net worth of the individual to the firm. First, the future returns in each time period must be known in dollar terms. In a profit maximizing firm, such a measurement of future returns may be possible since relevant prices are known with some certainty. (20:460-461) In dealing with a government agency which is not subject to market economic forces, it is much more difficult to actually estimate individual returns to the organization, or productivity. Secondly, one must know the number of years that the individual will be with the firm. In reality, there is a declining probability of employment in future time periods. (22)

The probability density function for T, the number of years of future employment from time T_o, can be approximated by past retention data for earlier workers. This model, as applied and altered to analyze the value of experience of trained officer personnel in the Air Force, will be further developed in the section on "The Model."

SECTION IV

THE MODEL

There has long been a recognition that the Air Force has significant dollar amounts invested in "human capital." (4:26) Each individual is trained, or gains experience, in his/her particular job which makes them more productive. It is fairly obvious when a trained/experienced individual leaves the Air Force that there will be certain replacement costs involved in getting another individual to that same level of experience or productivity. (4:29)

Using economic theory, one can make several assumptions about the hiring practices of the Air Force. These assumptions are central to any analysis and estimation of an individual's worth to the Air Force. Based upon these assumptions, one can then determine productivity (or return to the firm, in dollars) which will allow us to put a dollar value on experience.

Economic theory of the firm proves to us that the profit maximizing firm will hire a factor, in this case labor, as long as the marginal revenue product, MRP (returns to the firm) are greater than the marginal factor cost, MFC (cost of employing that factor). (20:310) The MFC includes compensation, training costs and retirement costs in the Air Force case. As more labor is added, the marginal productivity of additional workers will decrease, thus lowering MRP for a fixed level of capital. Labor will be hired up to the point where the marginal revenue product (MRP) produced by the last marginal factor will be exactly equal to the cost of the marginal factor (MFC).

(20:313) The quantitative model here will thus provide a lower bound estimate of the value of experienced labor in that it calculates the value of the last worker hired. It is difficult to put a price or dollar value on the output of an individual Air Force officer. Based upon the following assumptions and the model developed from them, the "value of productivity" will attempt to value that productivity. For purposes of this model, the following assumption about Air Force hiring practices will be made:

Assumption 1: The Air Force hires labor in such a manner that the expected amount of benefits to the Air Force, and hence National Defense, will be exactly equal to the expected amount of compensation paid to the officer over his/her association with the service plus the cost of his/her training. These expected returns and compensation will be based upon actual retention data for the appropriate AFSC's. This probability density function for retention will be combined with actual cost figures and the developed productivity estimates to meet the constraint of Assumption #1. The expected returns equalling expected costs can be described mathematically, as follows: The letters A-D pertain to the different areas in Figure 1.

$$\sum_{i=1}^{28} \frac{P_i \text{ (PROD) } F_i}{(1+d)^i} = \sum_{i=1}^{28} \frac{P_i \text{ (RMC}_i)}{(1+d)^i} + \sum_{r=20}^{28} \frac{P_r \text{ (RET}_r)}{(1+d)^r} + \text{ Training} \qquad (2)$$

P_i = Probability individual is in sample

PROD = FULL PRODUCTIVITY in Dollars

F_i = Proportion of full productivity in year i

d = discount rate

i, r = year

RMC_i = Direct compensation in year i

P_r = Probability of retiring in year r

RET_R = PDV of Retirement annuity, retiring after r years of service

TRAINING = Sum of Training costs to become "experienced"

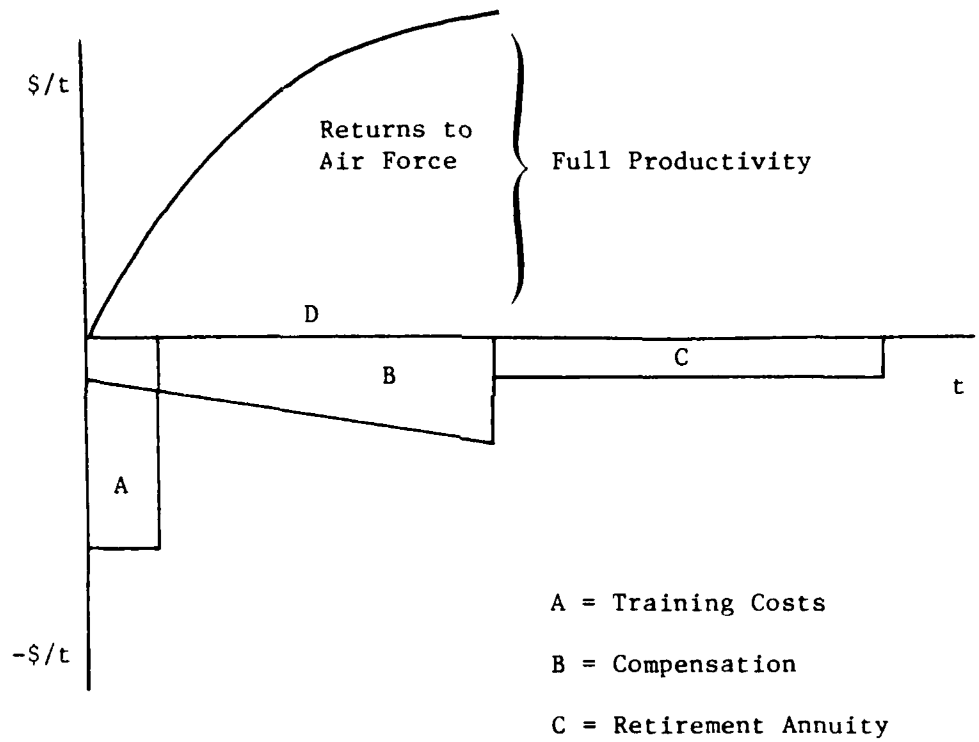

Figure 1

Assumption 2: This equality of expected benefits and costs (Assumption 1) applies to all Air Force Specialty Codes (AFSCs).

Assumption 3: An individual's productivity is an increasing function of his/her years of service, and increases at a decreasing rate as seen in Figure 2.

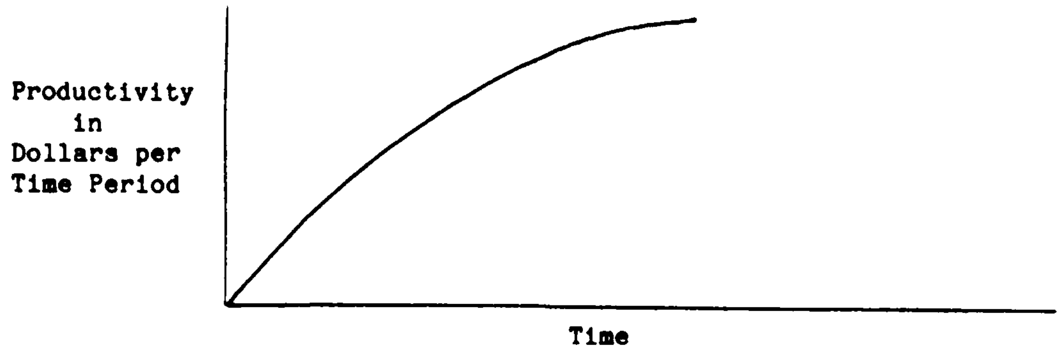

Figure 2

Based upon Assumptions 1 through 3, combined with appropriate learning curves for each AFSC, the model will determine the individual's productivity or contributions to the Air Force (in dollar terms) at any poii in his/her career. The estimation of the individual's productivity at any point in time is determined from Equation 2. On the right side of the equation, training costs, compensation and the probability of remaining in the Air Force, are all known. The training costs include formal training schools and the cost to reach a level of performance that the Air Force classifies as experienced. Probabilities of "survival" are the same on the left side of the equation. The only unknown is the dollar value of full productivity. This full productivity is multiplied by a fractional factor, F_i, which then gives the dollar value of productivity in each time period. A functional form is assumed that gives increasing productivity at a decreasing rate. This function also fits the productivity profiles provided by Air Force Personnel Managers. (9, 19, 22) This functional form is a quarter circle and provides for 50 percent productivity near three years and 70 percent productivity at six years for those in flying AFSC's. Productivity is assumed to increase at 4% per year after full productivity is reached since pay

increases by approximately that factor each year. The rate of productivity increase is faster for non-flying positions. (9, 19, 22) This calculation will then provide dollar figures for full productivity in Figure 1. Having solved for full productivity the dollar value of productivity for any time period can be determined by multiplying by the fraction of full productivity for that period. The dollar values in this profile will be different for each AFSC due to the different survival probabilities and different training costs. A calculated productivity profile for an F-15 pilot is shown below in Figure 3.

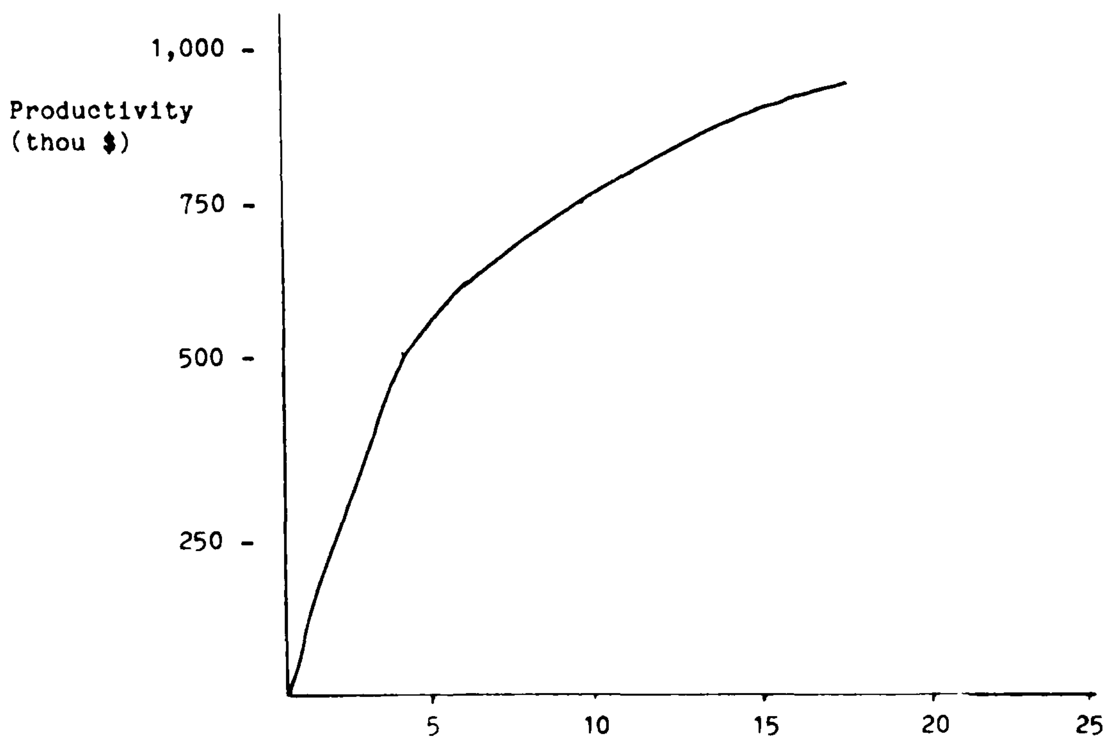

Figure 3

Once the productivity profile has been calculated one can enter the model with the appropriate data to estimate the value of

experience, based upon length of service and AFSC. Conditional probabilities must be calculated to determine probabilities of survival, given that the individual is still in the sample at the selected point in time.

Based upon Equation #1, at any point in the individual's career, his/her value to the Air Force will be equal to the sum of the following:

1. Replacement Cost - the sum of the cost of (a) all formal schools, (b) acquisition costs, (c) hiring costs, and (d) compensation to reach that level of experience. In the calculation of the productivity profile, full replacement costs were used to equate expected returns and costs. When valuing an individual's future value, one needs to take into account the realities of the personnel system. These replacement costs need only be taken into account if the individual is vital to the organization and must be replaced. If the individual is surplus, and his loss will not adversely affect output, then this replacement cost would be zero. In addition, some amortization of those costs would be appropriate as we can't expect people to work forever. The following calculations of an individual's value are worked out for a replacement cost of zero to avoid any over valuation of their worth to the Air Force.

2. Future expected <u>Net</u> Returns to the Air Force - This will be composed of three terms: (a) expected returns to the Air Force, based upon productivity arrived at through the model developed from the basic assumptions (positive); (b) compensation over future years of employment (negative); and (c) the expected value of retirement

benefits that would also have to be paid (negative). Each of these terms would be multiplied by the appropriate conditional probability to arrive at the expected value. The equation below shows the calculations for determining this value of experience for an F-15 pilot with eight years of service. His value of experience in this case is calculated to be 5.4 million dollars. Once the initial training has been completed, the returns far exceed the costs in subsequent time periods.

Since no two individuals are alike, the model will only give an average value of worth to an organization. Certain intangibles cannot be measured, but the model should be fairly representative of average experience values. Appendix A contains the calculations and data for valuing experience for several Air Force specialty codes, including F-15 Pilot, C-141 Pilot, B-52 Radar Navigator, Supply Officer and Aeronautical Engineer.

$$\text{Future Value} = \sum_{i=8}^{28} \frac{CP_i \, (PROD) \, F_i}{(1+d)^i} - \sum_{i=8}^{28} \frac{CP_i \, (RMC_i)}{(1+d)^i} - \sum_{r=20}^{28} \frac{CP_r \, (RET_r)}{(1+d)^r}$$

CP_i = Conditional Probability of being in the sample, given that the individual has survived through year 7.

CP_r = Conditional Probability of retiring in year r, given that the individual has survived through year 7.

Based upon these calculations, for an individual completing seven years of service, one can see that the future expected returns are positive for rated officers and negative for the two support officers

considered. Those officers with positive values of experience indicate that future returns to the Air Force exceed costs. Consequently, the Air Force receives more then it pays for over the future lifetime of the individual. In the case of the B-52 Radar Navigator, those future returns are more than 10 million dollars greater than future costs. The Air Force should thus do everything possible to realize this gain by seeking to keep the officer in the Air Force. AFSC's which show negative return for a particular individual's years of service indicate future costs exceeding benefits. If there is no shortage in this AFSC, the Air Force could institute policies providing incentives for these individuals to separate. The Air Force would save money by not incurring the excess costs of these individuals.

SECTION V

RECOMMENDATIONS AND CONCLUSIONS

All firms combine raw materials, labor and capital to produce output. In order to increase productivity of labor, training is provided to individuals. In addition, people become more productive over time in the same position as they gain experience. Economic theory also shows us under what conditions firms will be willing to make investments in this human capital. Based upon the fact that rational employers will only hire factors of production if their returns to the firm are greater than their total costs, the same assumption was made about Air Force personnel policies. From this basic assumption, a model was derived which determined the future expected value to the Air Force of experienced personnel. This model would allow for calculating the future expected returns for different AFSC's and different years of experience.

The results and implications of this model are useful for policy analysis. The calculation of an individual's future net worth to the organization tells whether the individual will provide returns greater than costs. Personnel policies could be adjusted to insure that the Air Force positively influences people with high future expected returns to remain in the Air Force. Conversely, those individuals with negative future returns could be influenced to separate by appropriate personnel policies.

Based upon the required experience vs. inexperienced personnel in each AFSC, an optimum distribution of years of service vs. number of

individuals could be determined within that AFSC. In those AFSC's with very high future returns (most notably rated AFSC's), efforts should be made to retain those individuals for as long a period as possible. Recent increases in post-pilot training commitments to eight years are positive indicators that action is being taken to preserve this human capital for the Air Force. Other personnel policies could also be implemented to provide incentives for individuals to voluntarily remain in the Air Force. These non-traditional policies might include skill specific pay bonuses (commonly used for enlisted personnel) or targeted promotion possibilities for critical AFSC's.

APPENDIX A

CALCULATIONS OF HUMAN CAPITAL VALUE

Appendix A contains the actual calculation for the productivity profile. The variables are defined as follows: All dollar figures in thousands of dollars. The data for these computations (experience requirements by AFSC continuation rates and training costs) was acquired from the appropriate Air Force agencies through a series of interviews and telephone conversations. This data was generally contained in written reports from the appropriate office of primary responsibility and is not available as published information.

Year = year in the sample

cont = continuation rate, probability that the individual is in the sample in year i. (9, 21)

rmc = total compensation, to include tax benefits of allowances

prod = F_i, factor for percentage of full productivity

E cost = expected cost, probability of being in sample multiplied by rmc

E prod = expected productivity, probability of being in sample multiplied by prod

prob ret = probability that an individual retires in year i. (9, 22)

retire = discounted value of retirement pay, retiring in year i. (12:11)

E ret = expected value of retirement, probability of retiring in year i multiplied by present value of retirement

Con P = conditional probability of remaining in the sample, given that the individual has survived through year 7. (9, 21)

E cost = expected cost, given the individual is in the sample after year 7

E prod = expected productivity, given the individual is in the sample after year 7

cexp ret = the conditional probability the individual will retire in year i, given that they have survived through year 7. (9, 21)

exp ret = conditional expected value of retirement, given that the individual has survived through year 7

F-15 PILOT

year	cont	rmc	prod	E cost	E prod	prob ret	retire	E ret	con P	E cost	E prod	cexp ret	exp ret
1	.99	22.41	.31	22.10	.31								
2	.96	22.41	.44	21.47	.42								
3	.94	27.76	.53	26.21	.50								
4	.93	32.04	.60	29.86	.56								
5	.92	37.54	.66	34.50	.61								
6	.91	37.54	.71	34.16	.65								
7	.83	41.16	.76	34.04	.63				1.00				
8	.76	41.16	.80	31.16	.60				.92	37.68	650.21		
9	.69	42.19	.84	28.90	.57				.83	34.95	614.88		
10	.64	42.19	.87	26.88	.55				.77	32.50	593.02		
11	.60	43.78	.89	26.31	.54				.73	31.82	576.95		
12	.57	47.43	.92	27.18	.52				.69	32.86	564.24		
13	.55	49.32	.94	27.03	.51				.66	32.68	551.40		
14	.54	49.32	.95	26.44	.51				.65	31.97	549.12		
15	.52	50.94	.97	26.64	.51				.63	32.21	544.24		
16	.51	50.94	.98	26.03	.50				.62	31.48	537.80		
17	.50	57.10	.99	28.61	.49				.61	34.59	532.12		
18	.48	57.10	.99	27.64	.48				.59	33.42	517.18		
19	.46	59.21	1.00	26.94	.45				.55	32.58	488.15		
20	.39	59.21	1.00	23.21	.39	.11	712	79.744	.47	28.07	421.40	.135	96.43
21	.28	60.21	1.04	16.86	.29	.14	729	99.144	.34	20.39	313.04	.164	119.88
22	.14	66.07	1.08	9.51	.16	.06	769	48.447	.17	11.50	167.19	.076	58.58
23	.08	68.56	1.12	5.55	.09	.02	782	17.986	.10	6.72	97.53	.028	21.75
24	.06	68.56	1.16	3.98	.07	.01	896	11.648	.07	4.81	72.33	.016	14.08
25	.05	68.20	1.20	3.07	.05	.01	907	12.698	.05	3.71	58.05	.017	15.35
26	.03	64.84	1.24	2.01	.04	.01	991	7.928	.04	2.43	41.32	.010	9.59
27	.02	69.34	1.28	1.59	.03	.01	999	7.992	.03	1.93	31.65	.010	9.66
28	.02	69.34	1.32	1.04	.02	.02	1004	15.06	.02	1.26	21.29	.018	18.21
Sum of Column				396.32	7.33			127.60		358.32	5994.70		203.04

train = 5990.00

Full Productivity = exp cost + exp ret + train / exp prod

Full Productivity = 889

Value of experience = exp prod - exp cost - exp ret

Value of experience = 5433

B-52 RADAR NAVIGATOR

year	cont	rmc	prod	E cost	E prod	prob ret	retire	E ret	con P	E cost	E prod	cexp ret	exp ret
1	.99	22.41	.31	22.21	.31								
2	.97	22.41	.44	21.80	.42								
3	.95	27.76	.53	26.43	.50								
4	.93	32.04	.60	29.70	.56								
5	.89	37.54	.66	33.56	.59								
6	.84	37.54	.71	31.61	.60								
7	.74	41.16	.76	30.62	.56				1.00				
8	.69	41.16	.80	28.48	.55				.93	38.28	1147.23		
9	.65	42.19	.84	27.21	.54				.87	36.58	1117.49		
10	.62	42.19	.87	26.03	.53				.83	34.99	1108.66		
11	.59	43.78	.89	25.96	.53				.80	34.89	1098.76		
12	.57	47.43	.92	27.13	.52				.77	36.47	1087.15		
13	.55	49.32	.94	27.32	.52				.74	36.72	1075.92		
14	.54	49.32	.95	26.39	.51				.72	35.47	1057.90		
15	.52	50.94	.97	26.59	.51				.70	35.74	1048.44		
16	.50	50.94	.98	25.52	.49				.67	34.30	1017.69		
17	.49	57.10	.99	27.86	.48				.66	37.45	1000.40		
18	.48	57.10	.99	27.18	.47				.64	36.53	981.72		
19	.46	59.21	1.00	27.06	.46				.61	36.37	946.33		
20	.38	59.21	1.00	22.44	.38	.10	712	73.336	.51	30.16	786.39	.138	98.57
21	.28	60.21	1.04	16.62	.29	.12	729	86.751	.37	22.34	595.58	.160	116.60
22	.16	66.07	1.08	10.37	.17	.05	769	40.757	.21	13.94	351.82	.071	54.78
23	.10	68.56	1.12	7.13	.12	.02	782	18.768	.14	9.58	241.68	.032	25.23
24	.08	68.56	1.16	5.48	.09	.02	896	18.816	.11	7.37	192.55	.028	25.29
25	.06	68.20	1.20	4.02	.07	.01	907	10.884	.08	5.41	146.90	.016	14.63
26	.05	64.84	1.24	3.05	.06	.01	991	11.892	.06	4.10	120.92	.016	15.98
27	.04	69.34	1.28	2.43	.04	.01	999	8.991	.05	3.26	92.96	.012	12.08
28	.03	69.34	1.32	1.80	.03	.03	1004	26.104	.03	2.42	71.21	.035	35.09
Sum of Column				389.16	7.19			123.89		394.29	11437.65		219.12

train = 10582

Full Productivity = exp cost + exp ret + train / exp prod

Full Productivity = 1544

Value of experience = exp prod - exp cost - exp ret

Value of experience = 10824

C-141 PILOT

year	cont	rmc	prod	E cost	E prod	prob ret	retire	E ret	con P	E cost	E prod	cexp ret	exp ret
1	1.00	22.41	.31	22.41	.31								
2	1.00	22.41	.44	22.41	.44								
3	1.00	27.76	.53	27.73	.53								
4	1.00	32.04	.60	31.88	.60								
5	.99	37.54	.66	37.13	.65								
6	.98	37.54	.71	36.75	.70								
7	.73	41.16	.76	29.88	.55				1.00				
8	.59	41.16	.80	24.45	.47				.82	33.68	426.37		
9	.52	42.19	.84	21.85	.43				.71	30.10	388.57		
10	.47	42.19	.87	19.96	.41				.65	27.49	367.99		
11	.45	43.78	.89	19.53	.40				.61	26.90	357.80		
12	.43	47.43	.92	20.25	.39				.59	27.90	351.38		
13	.41	49.32	.94	20.37	.39				.57	28.06	347.28		
14	.41	49.32	.95	20.07	.39				.56	27.65	348.45		
15	.40	50.94	.97	20.22	.38				.55	27.86	345.24		
16	.39	50.94	.98	19.76	.38				.53	27.22	341.24		
17	.38	57.10	.99	21.93	.38				.53	30.20	340.83		
18	.37	57.10	.99	21.24	.37				.51	29.26	332.19		
19	.35	59.21	1.00	20.96	.35				.49	28.87	317.38		
20	.33	59.21	1.00	19.24	.33	.11	712	76.896	.45	26.51	291.97	.149	105.92
21	.22	60.21	1.04	13.07	.23	.10	729	71.442	.30	18.00	202.74	.135	98.40
22	.12	66.07	1.08	7.86	.13	.04	769	29.222	.16	10.83	115.46	.052	40.25
23	.08	68.56	1.12	5.55	.09	.02	782	14.076	.11	7.65	81.50	.025	19.39
24	.06	68.56	1.16	4.32	.07	.01	896	11.648	.09	5.95	65.65	.018	16.04
25	.05	68.20	1.20	3.41	.06	.01	907	12.698	.07	4.70	53.90	.019	17.49
26	.04	64.84	1.24	2.33	.04	.01	991	7.928	.05	3.22	40.10	.011	10.92
27	.03	69.34	1.28	1.94	.04	.01	999	5.994	.04	2.67	32.20	.008	8.26
28	.02	69.34	1.32	1.53	.03	.02	1004	22.088	.03	2.10	26.09	.030	30.42
Sum of Column				350.85	6.46			106.10		316.12	3872.09		192.31

train = 3758.00

Full Productivity = exp cost + exp ret + train / exp prod

Full Productivity = 652

Value of experience = exp prod - exp cost - exp ret

Value of experience = 3364

SUPPLY OFFICER

year	cont	rmc	prod	E cost	E prod	prob ret	retire	E ret	con P	E cost	E prod	cexp ret	exp ret
1	.98	20.91	.40	20.53	.39								
2	.93	20.91	.66	19.40	.61								
3	.93	25.88	.81	24.02	.75								
4	.76	29.79	.91	22.58	.69								
5	.70	35.06	.97	24.65	.68								
6	.66	35.06	1.00	23.17	.66								
7	.63	36.36	1.04	22.87	.65				1.00				
8	.58	36.36	1.08	21.16	.63				.93	33.64	51.88		
9	.57	37.39	1.12	21.31	.64				.91	33.88	52.70		
10	.56	37.39	1.16	20.98	.65				.89	33.35	53.72		
11	.53	38.98	1.20	20.66	.64				.84	32.84	52.50		
12	.45	42.63	1.24	19.27	.56				.72	30.63	46.26		
13	.42	44.52	1.28	18.52	.53				.66	29.44	43.95		
14	.39	44.52	1.32	17.41	.52				.62	27.67	42.60		
15	.39	46.14	1.36	18.04	.53				.62	28.68	43.89		
16	.38	46.14	1.40	17.72	.54				.61	28.17	44.38		
17	.38	52.30	1.44	20.08	.55				.61	31.93	45.64		
18	.38	52.30	1.48	20.08	.57				.61	31.93	46.91		
19	.37	54.77	1.52	20.43	.57				.59	32.48	46.80		
20	.27	54.77	1.56	14.90	.42	.13	712	91.848	.43	23.68	35.03	.205	146.02
21	.14	56.13	1.60	8.03	.23	.07	729	47.385	.23	12.76	18.89	.103	75.33
22	.08	61.99	1.64	4.84	.13	.01	769	8.459	.12	7.69	10.56	.017	13.45
23	.07	64.84	1.68	4.34	.11	.01	782	10.166	.11	6.91	9.29	.021	16.16
24	.05	64.84	1.72	3.50	.09	.02	896	16.128	.09	5.57	7.67	.029	25.64
25	.04	64.84	1.76	2.33	.06	.00	907	0	.06	3.71	5.23	0	.00
26	.04	64.84	1.80	2.33	.06	.00	991	0	.06	3.71	5.35	0	.00
27	.04	69.34	1.84	2.50	.07	.04	999	35.964	.06	3.97	5.47	.057	57.18
28	.00	69.34	1.88	.00	.00	.00	1004	0	.00	.00	.00	0	.00
Sum of Column				293.00	8.42			89.171		332.03	504.48		186.55

train = 55.20

Full Productivity = exp cost + exp ret + train / exp prod

Full Productivity = 52

Value of experience = exp prod - exp cost - exp ret

Value of experience = -14.11

AERONAUTICAL ENGINEER

year	cont	rmc	prod	E cost	E prod	prob ret	retire	E ret	con P	E cost	E prod	cexp ret	exp ret
1	1.00	20.91	.40	20.89	.40								
2	1.00	20.91	.66	20.89	.66								
3	.99	25.88	.81	25.70	.81								
4	.88	29.79	.91	26.24	.80								
5	.81	35.06	.97	28.22	.78								
6	.78	35.06	1.00	27.17	.77								
7	.76	36.36	1.04	27.67	.79				1.00				
8	.76	36.36	1.08	27.56	.82				1.00	36.22	49.58		
9	.75	37.39	1.12	27.93	.84				.98	36.70	50.67		
10	.69	37.39	1.16	25.84	.80				.91	33.95	48.55		
11	.66	38.98	1.20	25.77	.79				.87	33.86	48.04		
12	.63	42.63	1.24	26.86	.78				.83	35.29	47.31		
13	.60	44.52	1.28	26.67	.77				.79	35.04	46.44		
14	.56	44.52	1.32	25.11	.74				.74	33.00	45.09		
15	.53	46.14	1.36	24.32	.72				.69	31.95	43.41		
16	.50	46.14	1.40	23.16	.70				.66	30.44	42.57		
17	.49	52.30	1.44	25.57	.70				.64	33.61	42.65		
18	.47	52.30	1.48	24.48	.69				.61	32.16	41.95		
19	.44	54.77	1.52	23.88	.66				.57	31.38	40.14		
20	.22	54.77	1.56	12.05	.34	.10	712	71.2	.29	15.83	20.79	.131	93.56
21	.12	56.13	1.60	6.74	.19	.07	729	47.385	.16	8.85	11.63	.085	62.27
22	.06	61.99	1.64	3.41	.09	.03	769	19.994	.07	4.48	5.46	.034	26.27
23	.03	64.84	1.68	1.88	.05	.01	782	7.82	.04	2.47	2.95	.013	10.28
24	.02	64.84	1.72	1.23	.03	.01	896	9.856	.02	1.62	1.98	.014	12.95
25	.01	64.84	1.76	.52	.01	.00	907	1.814	.01	.68	.85	.003	2.38
26	.01	64.84	1.80	.39	.01	.00	991	0	.01	.51	.65	0	.00
27	.01	69.34	1.84	.42	.01	.00	999	0	.01	.55	.67	0	.00
28	.01	69.34	1.88	.42	.01	.01	1004	6.024	.01	.55	.68	.008	7.92
Sum of Column				345.79	9.99			71.433		337.91	457.53		123.52

train = 43.12

Full Productivity = exp cost + exp ret + train / exp prod

Full Productivity = 46

Value of experience = exp prod - exp cost - exp ret

Value of experience = -3.91

APPENDIX B

INTERNAL LABOR MARKETS

There are two subject areas in the economic literature which, although not written with this purpose in mind, describe the military manpower situation very well. The first is the Human Capital Theory addressed at length in Section II. The second of these economic theories which bears on the problem of military manpower, is the concept of the Internal Labor Market. This theory was posited by economists P. B. Doeringer and Michael J. Piore in a book entitled Internal Labor Markets. This model appears to capture many of the realities of the military personnel situation. A short description of the model and its applicability to the Air Force might aid in understanding the reasons that we have the type of system that we do and some of its characteristics.

The Internal Labor Market is "an administrative unit, such as a plant or organization within which pricing and allocation of labor is governed by administrative rules and procedures."(6:I.1a) Conversely, an external labor market is one in which market forces govern labor activities. Movement between internal and external labor markets takes place at certain "ports of entry." These entry ports may be at any point within the hierarchy of jobs within a given organization. For the Air Force, entry ports occur only at the bottom of the rank structure, 2nd Lieutenant for line officers (certain professionals [Doctors, Lawyers, Chaplains, Nurses, etc.] enter at higher ranks, and are not classified as line officers) and Airman Basic for enlisted personnel. Labor thus enters at the bottom of each job ladder only, with no horizontal moves from outside the Air Force into a job position, other than at the bottom. (Prior service accessions enter at their former rank, but they have effectively not been lost.) We will now look at some of the characteristics of the internal labor market and how they describe the Air Force personnel system and the use of labor in the production of national defense.

Once within the internal labor market, the individual is 1) secure in his job from outside competitive market forces. The individual 2) then has "rights" to jobs above him within the firm and thus certain amounts of job security. 3) Promotions take place up the job ladder, primarily based upon seniority. Oftentimes, promotions are based upon seniority and not necessarily on ability. All three of these characteristics of the Doeringer and Piore model can be seen to describe certain aspects of the Air Force personnel system.

Certain factors tend to lead an organization towards the Doeringer and Piore Internal Labor Market model. These factors are 1) skill specificity, 2) on-the-job training and 3) customary law. A brief discussion of these three factors and how the theory applies to the Air Force Officer Personnel system will now be presented.

Firm specific skills will lead to the development of internal labor markets. Individuals will not invest in training for a firm specific skill. Consequently, the firm will pay for the training for such positions, but only if the expected returns are greater than actual costs. Many Air Force officer positions (primarily the combat related jobs) require firm specific training. Now the firm has an investment in the individual, and the individual has a need to stay with the firm to realize the firm specific gains (increased productivity and therefore salary) to his human capital.

The second factor leading to internal labor markets is on the job training. This is a way of life in the Air Force. The training of our aircrews is primarily done through OJT as is a large portion of our enlisted force training. Undergraduate Pilot Training, Undergraduate Navigator Training and upgrade training, although not formally OJT, does require the one-on-one teaching of a skill. The Internal Labor Market model describes the reasons by which some skills are taught in this fashion. Certain characteristics of our technical skills in the Air Force also lead to this type of training.

The third factor is that of customary law. In a firm, certain unwritten work rules become accepted over time. These may be as formal as union rules, seniority rights, etc. Customary rules become accepted by both labor and management. Labor policy thus becomes less influenced by, and less responsive to, outside economic forces. These constraints certainly apply to the Air Force. Not only do we have traditional personnel policies (such as movements to new jobs, promotions, rank structure, etc.) but there are formal laws passed by Congress which have a direct impact upon Air Force personnel management.

The process of internalization of the labor market can only take place if there are advantages to both the firm and the employee. In competitive markets, the firm lowers costs by retaining its workers for longer periods of time, (lowering turnover, training, replacement costs etc.) thus gaining increased returns on their investment in human capital. This investment was made when the firm paid for job specific skill training. In return for the longer tenure period, the firm provides job security and a known work environment. The worker gains from his training by increasing his value and therefore his compensation, while giving up some measure of job mobility since his specific training now ties him more closely to this firm.

One can easily see how the Air Force personnel system fits such a model. The theory tells us that such a market provides returns to both the firm (Air Force) and the individual. From the description of the model, it appears that this is true for the Air Force. The Air Force has internalized the Labor Market to guarantee the availability of the skilled labor force necessary to accomplish its mission.

The Internal Labor Market model just presented describes the factors which lead to the development of such labor markets and the characteristics of those organizations. The skill specificity factor and the gains to both labor and the firm are thoroughly presented in a theoretical manner in a related work by Gary S. Becker (4:15-37). In fact, the Doeringer and Piore work borrows heavily from Becker in its description of skill specificity and the differences between general and specific training. Thus Becker's work on human capital theory led them to the conclusion that investments in human capital altered the manner in which labor markets would allocate resources. Instead of a competitive, open labor market for all labor, segmented, internal labor markets have developed within the economy.

APPENDIX C

SUPPLY AND DEMAND IN LABOR MARKETS

Air Force Personnel problems can be analyzed by a very simple economic model that does not require the present "sophisticated model" of valuing human capital to the Air Force. Simple supply and demand analysis of individual labor markets yields all of the information necessary to assure the Air Force of a least cost means of meeting its manpower requirements. This assumes the Air Force knows the appropriate mix of experienced versus inexperienced personnel for optimal manning in each AFSC. The price system in the economy efficiently allocates resources to a wide variety of productive processes. Labor and its price (wages, salaries and benefits) are also allocated by this "invisible hand" which efficiently allocates labor within the economy.

The demand for labor in the Air Force is derived from requirements to perform certain tasks. Management Engineering studies are done to determine the number of individuals in each job skill necessary to accomplish Air Force missions. Thus the demand for each AFSC is fairly fixed and unresponsive to price in the relevant range of consideration. This demand curve would appear as a near vertical line on the traditional price/quantity graph.

The supply curve, on the other hand, is based on the willingness of individuals to offer their services in a particular occupation. This supply curve will be upward sloping, indicating that more people would be willing to offer their services at a higher level of compensation. Movement along this curve is simply a response to wages in this particular sector. Three basic factors will affect this supply curve itself and will cause it to shift over time. These are 1) the wages offered for other occupations (the opportunity costs of working in the current market, i.e. the Air Force) 2) the nonpecuniary aspects of the job and 3) unemployment rate, particularilly in related sectors.

The first of these factors, wages in other occupations, indicates the effect which the civilian sector and the overall marketplace has upon the supply of labor available to the Air Force. Simply stated, as wages in the civilian sector increase, labor supply available for an Air Force specialty will decrease for each wage level (a leftward shift in the supply curve for that specialty). Conversely, as wages in the civilian sector decrease, the willingness of individuals to work in the Air Force will increase, thus increasing the quantity of labor supplied at each wage level offered by the Air Force (a rightward shift in the supply curve).

Any equilibrium of supply and demand that does not occur at the desired quantity of labor for that specialty will result in a shortage or surplus of personnel in that field. Economic theory concludes that in specialties where we have a shortage, one remedy is to raise wages and in areas with a surplus, wages should be reduced in order to maintain the proper number of individuals in the specialty. Alternatively, the Air Force could attempt to shift the supply curve to the right, thus lowering the equilibrium wage to the Air Force wage. As we have seen above, the only way to do that is to affect the nonpecuniary aspects of the job since the Air Force cannot change the unemployment rate or wages in the private sector.

The nonpecuniary aspects of the job are affected by certain Air Force policies which contribute to the overall "quality of life." The perceived work environment, societal attitudes, level of patriotic fervor, and the benefits available in the Air Force all will have an impact on the supply of labor available for each AFSC. This list is certainly not a complete list of all the factors which affect individual's willingness to serve in the Air Force.

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